Changes in Phytoplankton Biomass and Zooplankton Abundance

MSFD Descriptors: 1 - Biological diversity; 4 - Marine food webs

MSFD Criteria: 1.6 - Habitat condition; 1.7 - Ecosystem structure; 4.1 - Productivity (production per unit biomass) of key species or trophic groups

Key Message Plankton form the base of the marine food web and respond rapidly to environmental changes. Local and large-scale changes in phytoplankton biomass and zooplankton abundance (beyond natural variation) were observed over the period 1958–2002, providing a possible early warning of a wider change in the marine environment

Background

Plankton organisms (both phytoplankton and zooplankton) form the base of the marine food web and are highly sensitive to physical and chemical factors, including nutrient concentration, salinity, and temperature. These factors are dependent on natural variation in climate and hydrography, as well as human-induced processes. Due to their short lifecycles, plankton communities respond rapidly (potentially more rapidly than other trophic levels) to these processes. Plankton-based indicators therefore have the potential to detect those changes at an early stage. Plankton is also essential for organisms higher up the food web, such as shellfish, fish and seabirds, and changes in the plankton community can thus impact on the whole marine ecosystem.

This indicator based on phytoplankton biomass and zooplankton abundance, provides a means to identify changes (anomalies) in key groups within the plankton community; changes which represent deviations from the assumed natural variability in the plankton time series. These are identified as small, important or extreme changes). This indicator can also help to understand changes in other parts of the marine food web. It has been assessed at two scales: large-scale (ecohydrodynamic regions) and small-scale (coastal stations). When combined with the two other pelagic indicators (that look at changes in plankton lifeform and changes in plankton diversity), it will enable a more sensitive detection of change at the plankton community level.

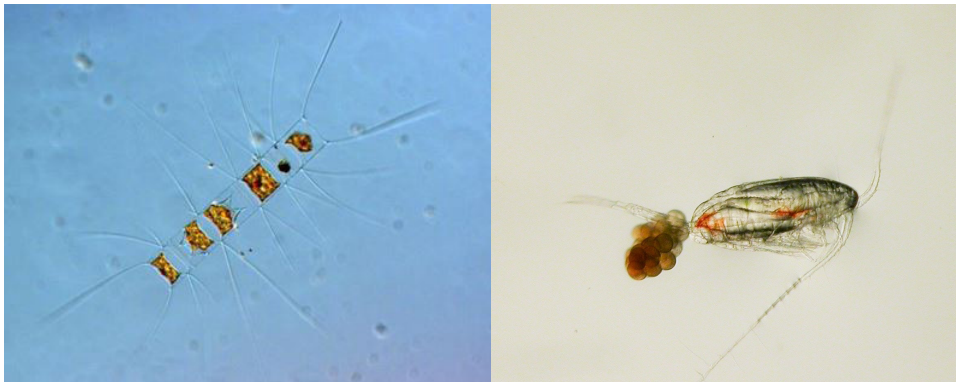


Image (left): Phytoplankton of the genus Chaetoceros and (right) A copepod, the most common type of zooplankton organism © Anais Aubert

Results

For phytoplankton, the time-series can be subdivided into four main periods (**Figure 1**). From the start of the time-series (1958) to around 1965, most anomalies are negative and qualified as important changes. The period 1965-1975 then appears relatively stable and characterised by small changes in phytoplankton biomass. From 1975, a decrease occurred with mostly negative anomalies, categorised as important changes in phytoplankton biomass. In fact, this period is recognised as marking a regime shift in the North Sea. The phytoplankton biomass after 1985 and up to 2012 mostly exhibits positive anomalies categorised as small and important scale change, with very few exceptions. The anomalies increase in strength, and are qualified as important, between 2010 and 2012.

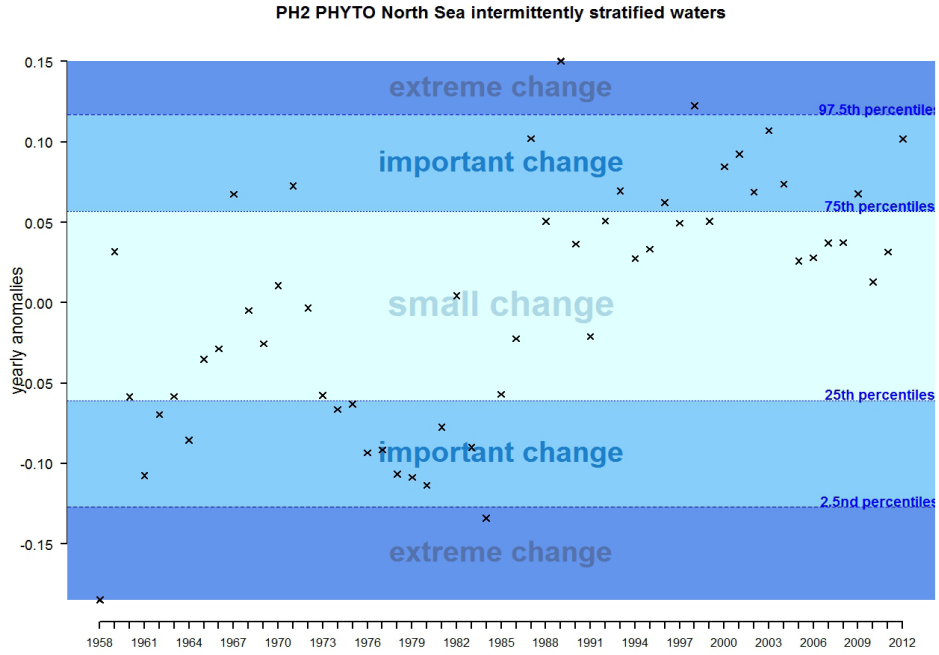


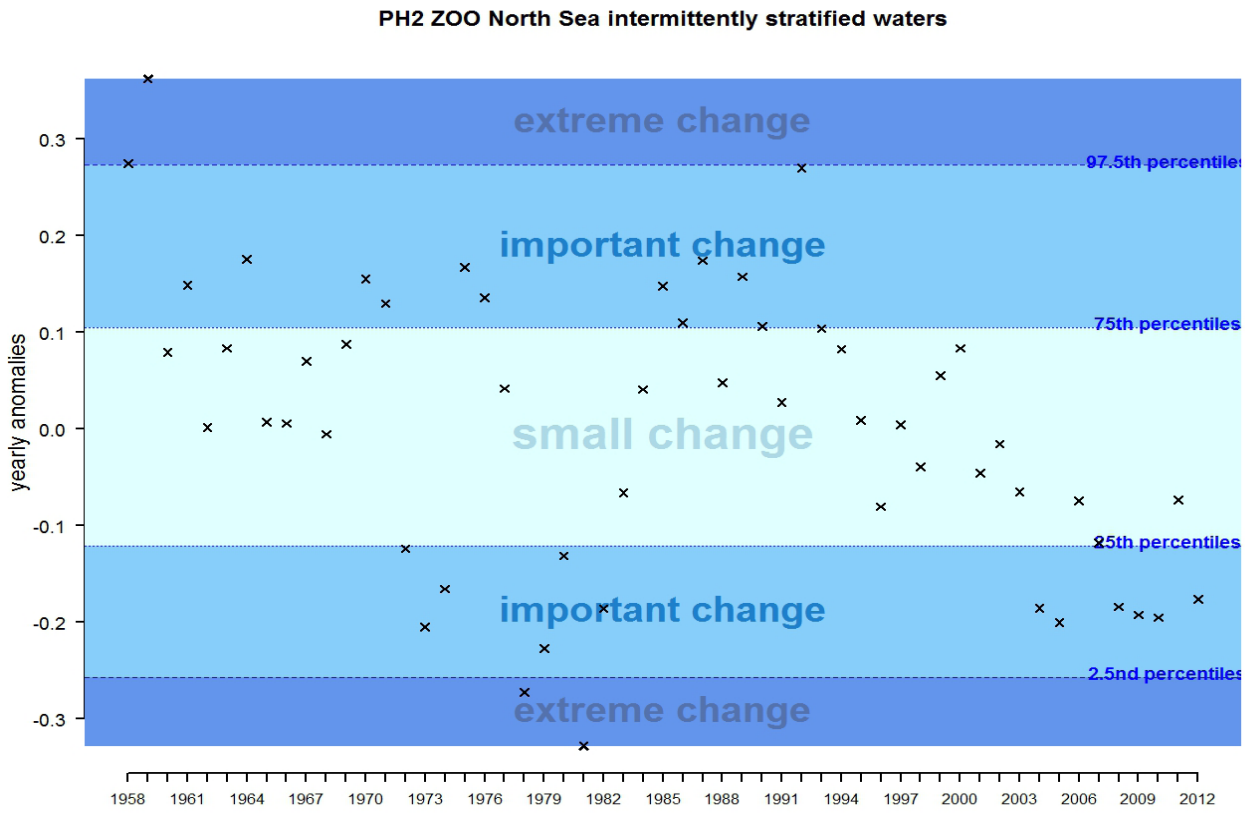
Figure 1: Annual anomalies for phytoplankton biomass for the Greater North Sea for intermittently stratified waters over the period 1958–2012

Changes in Phytoplankton Biomass and Zooplankton Abundance

Results cont...

For zooplankton, the time-series of annual anomalies shows five main periods between 1958 and 2012 (**Figure 2**). The time-series exhibits positive anomalies representing extreme change at the start (1958–1959) followed by a period with positive anomalies showing important and small change, between 1960–1972. After 1970, we see mostly negative anomalies and categorise these as important changes with some notable extreme negative anomalies around 1980. This shows a clear decrease in zooplankton abundance over this period. This period also corresponds to a well-known regime shift and fish stock decline in the North Sea. From 1982 to 2006, zooplankton abundance increased with mostly positive anomalies exhibited, and with some important changes, up to the mid-1990s. Subsequent anomalies are negative, and start to be for most of them, qualified as important changes from 2004 to 2012 showing a decrease in zooplankton abundance. The results tend to show that for this EHD zone (intermittently stratified waters) and for the known regime shift of the early 1980s, that zooplankton abundance exhibits stronger negative anomalies than phytoplankton biomass. For the most recent period after 2000, the results show two opposing tendencies: zooplankton abundance tending to decrease while phytoplankton biomass tended to increase. These results need to be related to knowledge about environmental variability and human pressures in order to fully interpret them.

The methods and data for this indicator are considered to be of moderate confidence.



Conclusion

This indicator shows the variation in phytoplankton biomass and zooplankton abundance for large geographic areas (ecohydrodynamic zones and entire OSPAR regions) and some small scale coastal stations. The indicator is based on the identification of changes calculated through time-series anomalies of phytoplankton biomass (chlorophyll-a and Plankton Colour Index) and zooplankton abundance (total copepod abundance).

The assessment is preliminary and shows that important scale changes occurred, acting as an early warning and flagging a potential issue for the wider marine ecosystem.

Knowledge Gaps

Further work recommendations are as follows: 1. Further interpretation of the results in detail, considering monthly anomalies and scientific knowledge expertise of the studied geographical assessment unit;
2. Link with environmental and anthropogenic pressure data to interpret the changes; and 3. Definition of reference periods related to GES (Good Environmental Status).

Figure 2 (left): Annual anomalies for zooplankton abundance for the Greater North Sea for intermittently stratified waters over the period 1958–2012

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The full assessment can be found at www.ospar.org/assessments